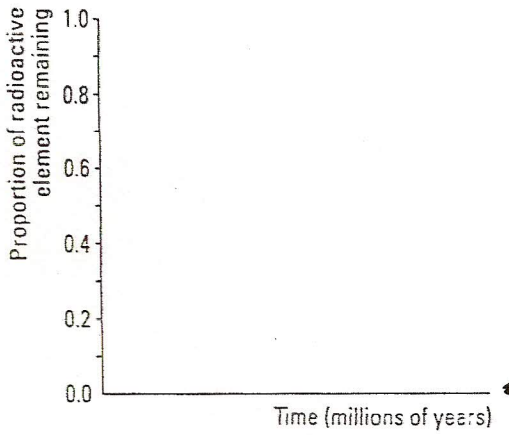
HOW OLD ARE ROCKS?

There are two radioactive isotopes of uranium which geologists can use to date rocks. Uranium-238 has a half-life of about 4500 million years and decays, in the end, to lead-206. Uranium-235 has a half life of about 700 million years and decays, in the end, to lead-207.

to do

- Plot decay curves for the two uranium isotopes on two separate graphs.
- For both plots, show the proportion of uranium remaining with a scale running from 0 to 1.0 on the vertical (*y*-axis).
- Show time in millions of years on the horizontal (*x*-axis). For uranium-238 have a scale from 0 to 20 000 million years. For uranium-235 have a scale from 0 to 3500 million years. **214**



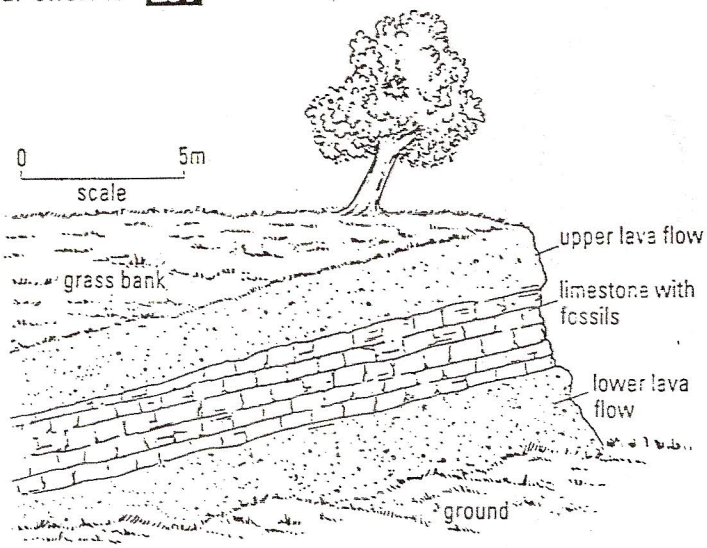
questions

1 If only 0.4 (four tenths) of the original uranium-238 is left in a rock sample, how old is it likely to be?

2 No-one has found a rock on Earth with less than half of its original uranium-238 left. What does this suggest?

3 Which isotope of uranium can be used to find the age of a rock which is about 100 million years old? Explain your choice. **204**

The diagram shows a bed of limestone containing fossils. There are lava flows above and below the limestone. Analysis of a sample of the lower lava flow shows that it contains 60 atoms of uranium-235 to 40 atoms of lead-207. Analysis of a sample of the upper lava flow shows that it contains 130 atoms of uranium-235 to 70 atoms of lead-207.



questions

4 Assume that all the lead-207 has come from the radioactive decay of uranium. How many atoms of uranium-235 did each lava sample contain when they were first formed?

5 From your decay curve for uranium-235, estimate the ages of the two lava flows.

6 Estimate the age of the limestone.

7 The limestone contains traces of uranium-235.

a Where might this uranium-235 have come from?

b Estimating the age of the limestone from this uranium-235 does not give a sensible date. Why not?

8 In practice, scientists date rocks several times using the radioactive isotopes of several elements including uranium, potassium and rubidium. Why do they do this? **220**

How old are Rocks?

DATA: U^{238} $T_{1/2} = 4{,}500{,}000{,}000$ yrs → Pb^{206}
U^{235} $T_{1/2} = 700{,}000{,}000$ yrs → Pb^{207}

QUESTIONS

(1) 0·4 of U238 remains → age from earth = 5800 million years
(2) If fraction is 0·5 then age is 4500 million years
This implies earth is not older than 4500 million years.
(3) In order to maximise accuracy it would be better to use

DATA:

Lower Lava	60 atoms	U235	40 atoms	Pb 207
Upper Lava	130 atoms	U235	70 atoms	Pb 207

(4) Assuming all Pb207 comes from U235
Lower lava atoms U235 = 100
Upper lava atoms U235 = 200

(5)

Lower	60% remain	0·6 →	550 million years
Upper	65% remains	0·65 →	470 million years

(6) Limestone is half way between two? $\frac{550+470}{2} = 510$ million years old

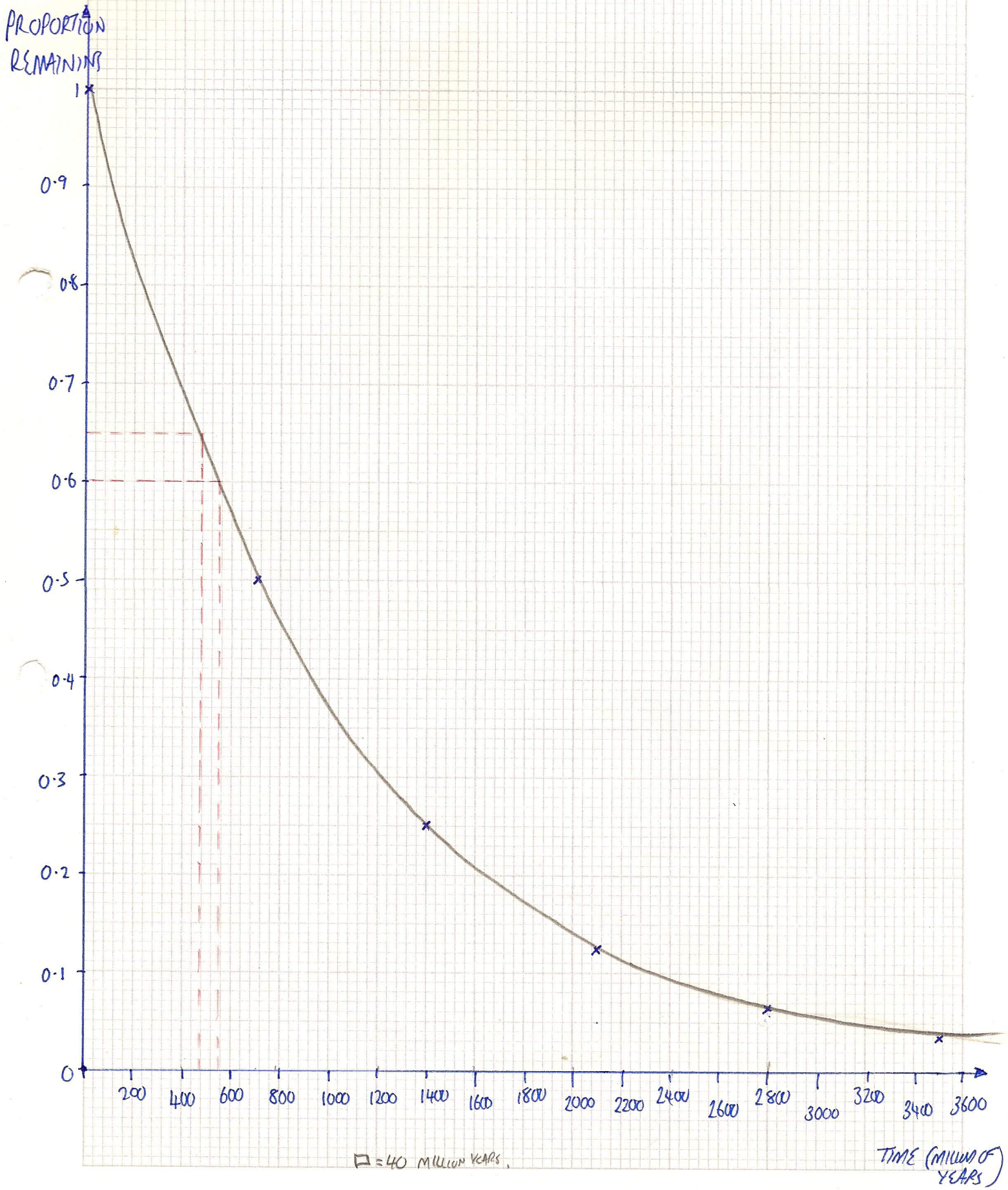
(7) a) The U235 could have come from fragments of lower lava flow "floating" around the 'fossils'

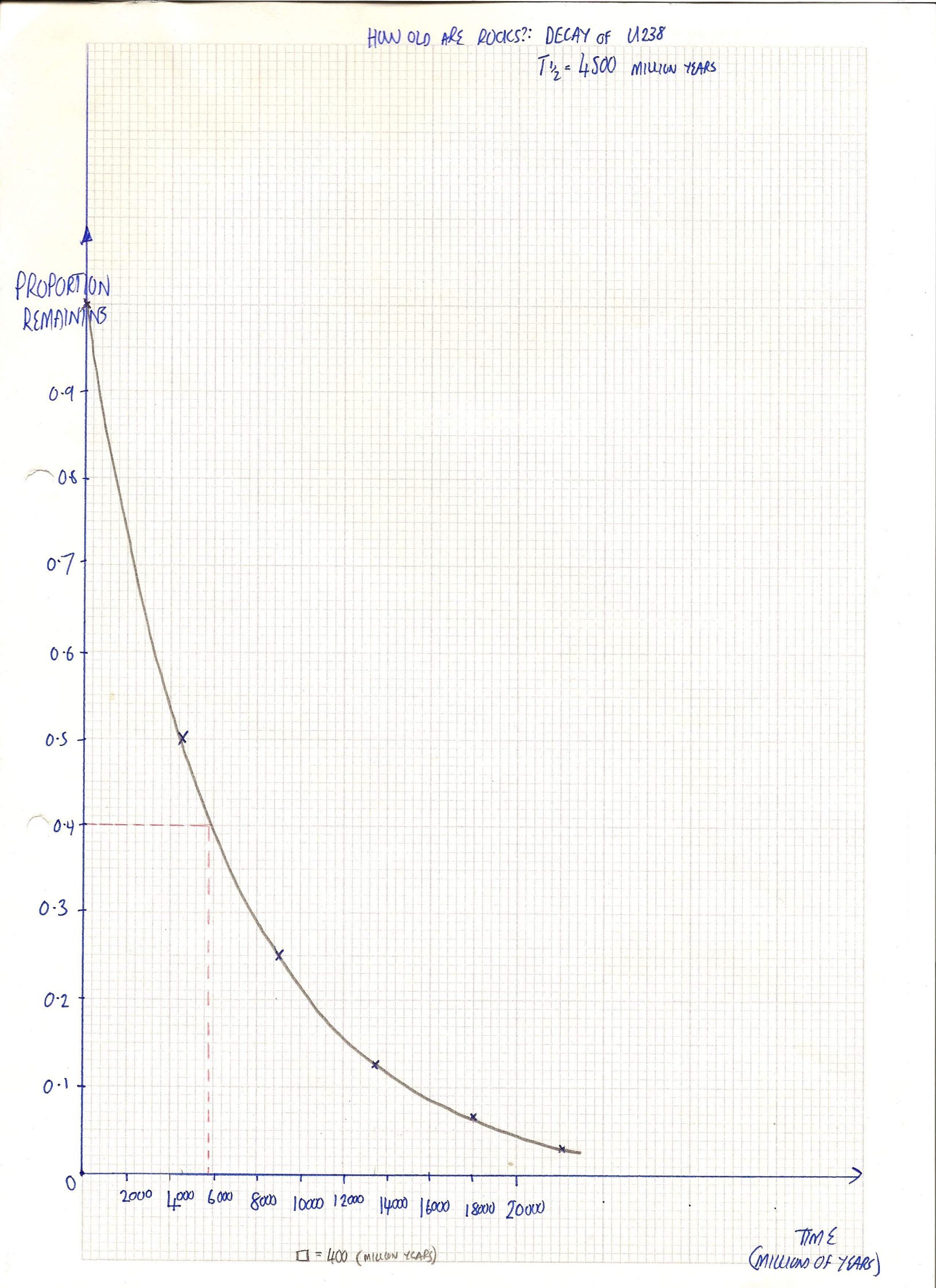
b) The U235 in the limestone

(8) In order to minimise any errors (inaccuracies from supply, random nature of decay, local anomalies → making a fairer picture

HOW OLD ARE ROCKS?: DECAY OF U235

$T_{\frac{1}{2}}$ = 700 MILLION YEARS




HOW OLD ARE ROCKS?: DECAY OF U238
$T_{1/2}$ = 4500 MILLION YEARS
PROPORTION REMAINING
0·9
0·8
0·7
0·6
0·5
0·4
0·3
0·2
0·1
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
□ = 400 (MILLION YEARS)
TIME (MILLIONS OF YEARS)